

The Influence of Ratio-Reinforcement on Video-Gaming Behaviour.

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## **Statement of Sources**

I declare that this report is my own original work and that contributions of others  
have been duly acknowledged.

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### **Abstract**

The rapid growth in videogame popularity has sparked considerable public and scientific interest regarding the negative effects of increased exposure and prolonged gameplay. Informed primarily by basic operant conditioning principles this study tested the influence of ratio-based schedules of reinforcement on participant video-gaming duration. It was firstly hypothesised that in-game ratio-reinforcement would significantly contribute to longer gameplay duration when compared to a no reward control condition and, secondly, that rewards awarded on a variable-ratio schedule would be more effective at prolonging gameplay than those awarded on a fixed-ratio schedule. Fifty-one participants were assigned to one of the three reinforcement conditions. Each played a puzzle based video game and their gameplay statistics including playing duration, level restarts (indexing persistence following failure) and flow experience were measured. Ratio-reinforcement significantly extended video-gaming duration, and increased persistence following failure, compared to the control condition. Despite a non-significant difference, there was also evidence to suggest the increased effectiveness of variable- over fixed-ratio reinforcement in prolonging gameplay. The current research provides strong initial evidence for the ability of video-game reinforcement to significantly increase gaming duration, and represents an initial step in understanding prolonged and potentially problematic video-game play.



Technological advances over the last decade have made it possible to create seemingly real videogame environments, allowing users to participate in a huge variety of activities and goal completion tasks (Ryan, Rigby & Przybylski, 2006). Statistics indicate that in the United States up to 91% of children now play videogames (Granic, Lobel, Engels & Ruster, 2014) which has contributed to a rise of over 5 billion dollars in annual sales from 2009 to 2013 (Siwek, 2014). This rapid growth in popularity has contributed to an increasing interest by both scientific and media sub groups in the potentially adverse effects of videogames (Hull, Williams & Griffiths, 2013), with the large majority focusing on videogame violence (e.g. Mitrofan, Paul & Spencer, 2009; Sauer, Drummond & Nova, 2014; Greitemeyer, 2014). The current paper is however interested with the somewhat broader area of prolonged and potentially problematic video-gaming durations.

Problem gaming, commonly defined as over 50 hours per week, has been a topic of increased interest in video-gaming literature mainly due to the behaviour's proposed consequences (King, Delfabbro & Griffiths, 2011). There is marked concern among health professionals for individuals who display these types of gaming durations with suggestions it can negatively affect a variety of life domains including school or work productivity, sleep patterns, social relationships and psychological health and wellbeing (King et al., 2011). What is less understood are the structural mechanisms of videogames which contribute to prolonged gaming durations and the associated negative consequences (Przybylski, Ryan & Rigby, 2010). In this study we investigate how structural design characteristics of videogames, specifically in-game reinforcement structures, can contribute to prolonged and potentially problematic gameplay durations.

A greater understanding of how excessive gaming behaviours manifest is becoming especially important given the recent “Freemium” trend, and its associated economic implications. Freemium games can be downloaded for free but contain internal monetary transactions allowing users to buy additional content or advance their position within the game (Page, 2012). Common examples include *Family Guy: The Quest for stuff* and *Zhengtu* (Page, 2012). These ‘micro-transactions’ allow users to bypass game-imposed waiting periods or to gain access to otherwise unavailable game content. For example in *Family Guy: The Quest for Stuff*, the in-game currency of ‘clams’ can be used to bypass waiting periods or to unlock new characters for use within the game. It costs users one clam to bypass each one hour waiting period the game imposes, reaching up to 48 hours, while it costs up to 100 clams for each new character they wish to unlock. Players can choose to purchase ‘packs of clams’ with real money, ranging from \$1.99US for 50 up to \$99.99US for 3500 clams. This freemium design allows producers to market their game as free (to assist in attracting an initial customer base) but structurally design it to be almost impossible to compete against opposition players who take advantage of the micro-transactions (Page, 2012). This has resulted in freemium games being commonly referred to as ‘pay-to-win.’ The micro-transactions are configured so users only enter their payment details on the first purchase, making subsequent purchases fast and simple. Micro-transactions are aimed at facilitating impulse buying; sudden and hedonic buying behaviour where the rapidity of the decision happens before the individual has a chance to consider alternative and important information (Bayley & Nancarrow, 1998). These behaviours are often more arousing and less deliberative in comparison to planned purchasing (Kacen & Lee, 2002), causing players to take advantage of the seemingly small transactions and pay little attention to the potentially negative

consequences (Hoch & Loewenstein, 1991). Structural characteristics of freemium games point users towards using micro-transactions to advance their position and their enjoyment in even very basic games. Thus, as seen in other impulsive spending contexts (e.g. gambling), prolonged or problematic gaming behaviours that increase spending on freemium platforms have the potential to lead to financial problems.

As a result of video-gaming research there have been increasing calls among addiction researchers for problematic gaming to be defined as an addictive behaviour. This is largely due to the fact that it shares many characteristics with already defined addictive behaviours such as poker-machine gambling (Festl, Scharnow & Quandt, 2013). This idea has attracted a huge amount of controversy given the conceptual requirements for a definable addiction, including mood modification and inordinate salience (King et al., 2010). Some researchers believe that characteristics such as these are purely signs of engagement within the gaming environment, and thus don't constitute a label as intense as addiction (Charlton & Danforth, 2007). Despite this debate, prolonged and problematic video-gaming is a considerable problem, with those meeting this proposed addiction status ranging from 0.3-5 percent of the population, with some specialist populations recording much higher rates, for example college student populations which have measured up to 15 percent (King, Delfabbro & Griffiths, 2013).

Despite common references to similarities between videogames and poker-machines (Wood, Griffiths, Chappell & Davies, 2004), there is a distinct lack of experimental research uncovering the mechanisms and structural characteristics that prolong video-gaming duration. We suspect there exists a large body of proprietary knowledge on this topic, but the absence of this information in peer-reviewed scientific outlets is surprising. Discussion of goal-directed game-play has largely

been ignored by mainstream psychological literature (Oswald, Prorock & Murphy, 2014), with current research mainly focused upon the circumstances under which videogames exert positive (e.g. increased self-confidence and efficacy in learning domains; Evans, Norton, Chang, Deater-Deckard, & Balci, 2013) or negative influences (e.g. impaired productivity or sleep patterns; King et al., 2011; Przybylski, Rigby & Ryan, 2010). Schell (2008) believes that to be successful videogame design must be focused on promoting player engagement and as such it is highly likely that game developers have researched characteristics that enhance player engagement and are making use of psychological literature to assist in promoting engagement in order to extend play time (Evans et al., 2013). However as there is little to no evidence to suggest this available to the public (Wood et al., 2004), further research is needed to pinpoint structural characteristics with the potential to directly influence video-gaming duration and in extreme cases contribute to problem gaming (Wood et al., 2004).

The current paper aims to partially fill this literature gap by quantifying the effects of fixed- and variable-ratio in-game reward schedules on gaming duration. We draw on principles of motivation, addiction and gaming literature to explain potential differences observed between our design conditions. It is important to note that there is a sister study concerning the effects of interval schedules on gameplay duration and as such interval schedules will not be covered. We will discuss three mechanisms through which in-game reinforcement is believed to influence participant game-play duration including; basic operant conditioning principles (Ferster & Skinner, 1957), the fulfilment of the psychological need for competence (Ryan et al., 2006) and on an exploratory basis, the principles of flow

(Csikszentmihalyi, Abuhamdeh, & Nakamura, 2005). We then directly test the effect of our reward schedules on participant video-gaming duration.

### **Operant Conditioning: Basic Principles**

Basic operant conditioning principles state that a reinforced behaviour is more likely to occur than one that is not reinforced (Thorndike, 1927). Thorndike's 'Law of effect' provided a basis for operant conditioning research, suggesting that behaviours met with desirable consequences (e.g. a reward) are more likely to occur than those met with both undesirable consequences or no response at all (Thorndike, 1927; Thorndike, 1898). Schedules of reinforcement refer to the timing of reinforcement used to reward and maintain desirable behaviour (Ferster & Skinner, 1957). Continuous reinforcement, in which all examples of desirable behaviour are reinforced (e.g. giving a dog a treat every time it is instructed to sit and does so) is less effective at continuing desirable behaviour than intermittent schedules where behaviour is rewarded following a set number of responses or amount of time (Kendall, 1974). The two main types of intermittent reinforcement are ratio- and interval- schedules. Ratio-schedules rely on reinforcement presentation after a set number of correct responses, whereas interval-schedules rely on reinforcement after a set period of time has passed. The molar view to reinforced behaviour suggests ratio-schedules are more effective in maintaining desirable behaviour due to a participant sensitivity for the overall correlation between their response rate and the received reinforcement (Baum, 1973). The faster an individual responds on a ratio-schedule, the faster they receive a reward, however this is not the case for interval-schedules (Reed, 2001). As previously indicated, a sister-study will be analysing the influence of interval schedules and as such, they will not be discussed further. Within ratio-schedules, there are fixed and variable reward placements. Fixed placements

refer to reinforcement after a set number of responses, whereas variable refers to reinforcement after a strategically varying amount of responses (however still on the same average response rate as fixed-ratio; Killeen, Posadas-Sanchez, Johansen & Thrailkill, 2009).

**Operant Conditioning: Experimental Research.** Evidence supporting the effectiveness of reinforcement schedules in producing desirable behaviour is pervasive and robust. Early research showed the effectiveness of reinforcement in maintaining desirable behaviour in cat, rat and pigeon studies (Thorndike, 1898). The application of these basic operant conditioning principles were also found to be generalisable to humans (Verplanck, 1956; Siqueland & Lipsitt, 1966). Building upon this, pigeon research found the effectiveness of intermittent reinforcement, where desirable behaviour was only reinforced after a set number of responses, to be greater than continuous reinforcement in continuing desirable behaviour (Kendall, 1974). Pigeon studies also indicated a preference for variable-ratio reinforcement over fixed-ratio due to a post-reinforcement pause seen in fixed-ratio conditions (Ferster & Skinner, 1957). When reinforcement is presented on this fixed-ratio schedule, participants quickly learn that following a reinforcement they won't gain another reward for at least a short duration, resulting in a post-reinforcement drop in responding (Felton & Lyon, 1966). This same preference was also found in rhesus monkeys (Lagorio & Winger, 2014) and is considered consistent across animal species (Reed, 2011). Even when participants in variable-ratio conditions are required to show twice the amount of desirable behaviour to receive reinforcement, they are still able to produce a greater rate of responding when compared to a standard fixed schedule (Field, Tonneau, Ahearn & Hinline, 1996).

Similar effects occur in human populations when comparing fixed-ratio to variable-ratio schedules. Initially there is a similar rate of responding, until fixed-ratio reinforcement begins to show a post-reinforcement pause. This reduces its effectiveness when compared to the variable-ratio schedules (Skinner, 1953). As this post-reinforcement pause reduces the rate of responding (Felton & Lyon, 1966), it could be argued that it would increase the chance of behavioural extinction in a continuous desirable behaviour like video-gaming.

To further the effectiveness of the basic operant conditioning principles, Hapogian, Boelter and Jaemolowicz (2011) developed a schedule thinning technique for their Functional Communication Training (FCT), a treatment aimed at identifying and developing alternative responses to problem behaviour. Although effective during intervention, the researchers observed that a normal ratio-schedule was not maintaining desirable behaviour after the intervention phase. To improve this problem, they altered the original reward schedule with a schedule thinning manipulation where the frequency of reinforcement was reduced over time. This technique significantly improved the maintenance of desirable behaviour post-intervention (Hapogian et al., 2011). Schedule thinning however, does have the potential to weaken the relationship between reinforcement and desirable response (reducing the likelihood of desirable behaviour) if the gap becomes too large (Hapogian et al., 2011; Leung, 1993). Longer segmentation between instances of reinforcement increases the participant's psychological distance to reward. This means that participants will start to feel as if the reinforcement is further and further away, potentially to the point where the perceived costs of the desirable behaviour outweigh the perceived benefits of the reward. This will reduce extrinsic motivation to seek the reinforcement and can lead to behavioural extinction (Leung, 1993).

Although there is strong evidence to support the effectiveness of schedule thinning, there is very little guidance in the literature on how to thin rewards in the current study's domain. As such there is a small possibility that the predicted reinforcement effectiveness may not be found within a video-gaming environment.

### **Operant conditioning: Applications to Poker-machines and Videogames**

One of the most commonly researched real-world application of ratio reinforcement's influence on behaviour, is poker-machine gambling (Skinner, 1953; Ferster & Skinner, 1957; Delfabbro & Winefield, 1999). Poker-machine gambling is considered a highly disciplined, schedule-based behaviour, where the timing of rewards are pre-determined and highly controlled (Ferster & Skinner, 1957). Evidence suggests that when poker-machines return small wins on a short variable-ratio schedule, participants are more likely to continue playing than when the machines returned bigger reinforcements on a longer ratio schedule (Delfabbro & Winefield, 1999). For example, if individuals win \$2 once in every 5 attempts, they are more likely to continue playing than if they win \$50 once every 100 attempts. This trend is observed across all populations but more strongly in habitual or regular gamblers (Delfabbro & Winefield, 1999). If gambling behaviours become linked to reinforcement, motivation to gamble will be heavily affected by the thought of external rewards (e.g. potentially winning money; Delfabbro & Winefield, 1999). Thus, when exposed to these external rewards, common gamblers may find it more difficult to extinguish the behaviour when compared to someone who is not commonly exposed to this type of reinforcement. This finding is extremely important to addiction literature as being able to understand excessive gambling in terms of learning theory, allows an understanding of how and why individuals become



entrapped by excessive and potentially damaging behaviours (Delfabbro & Winefield, 1999).

Although videogame use is not classed as an addictive behaviour, videogames share many structural similarities with poker-machines (Festl et al., 2013). The activation of neural response cues associated with videogames, for example seeing an advertisement for a particular game, influence users in the same way as other addictive behaviours. The excessive rewarding of game-play behaviour contributes to a heightened motivational response when in an unrelated environment if the player comes into contact with some form of game-related cue. When in the gaming environment, these rewards contribute to repeated and excessive gameplay behaviours commonly increasing gameplay duration (Thalemann, Wolfing & Grusser, 2007). These are the same cue-response patterns commonly seen in pathological gamblers (Grusser, Plontzke & Albrecht, 2005).

Despite the apparent similarities between the structures of poker-machines and videogames there has been very little written about the influence of videogame characteristics on gaming behaviour and even less experimental research conducted (Wood et al., 2004). Anecdotally, it has been argued that poker-machines and videogames influence users on both psychological and behavioural levels through similar mechanisms designed to prolong gameplay duration (Wood et al., 2004). These mechanisms included characteristics such as graphics, lights, sounds, game dynamics and reinforcement or 'winning and losing', all of which are common to both poker-machines and modern videogames (Wood et al., 2004). What is potentially unclear however are the similarities between the monetary poker-machine rewards and the in-game meta-rewards of videogames. It is suggested that despite their obvious difference, the addictive nature of the reinforcement schedules may

contribute to them influencing users in the same way (Wood et al., 2004), prolonging gameplay duration and potentially contributing to problematic gameplay behaviour.

In an attempt to make the comparison between poker-machine gambling and video-gaming behaviour more clear, King et al. (2010) assessed player perceptions of structural characteristics in videogames that were thought to initiate and maintain game playing, to see which were considered most enjoyable. ‘Reward and punishment’ features were reported to be one of the most enjoyable and influential characteristics contributing to motivation to engage with videogames. Like gambling on poker-machines, many of these reward features are presented on either variable or fixed-ratio schedules (Chumbley & Griffiths, 2006). For example, many modern videogames allow players to ‘rank-up’ their character with experience points gained throughout challenges. As subsequent levels are reached, more experience points are needed to continue ranking up, which is strongly related to the schedule thinning technique discussed earlier. Based on player response rates, the timing of the rewards given to players are believed to be as important, if not more so, than the actual reinforcement itself (King et al., 2010) suggesting the potential for a significant influence of the reward schedules gaming duration. Yee (2006) believes that due to the variable nature of many in-game rewards, players report that collecting the last rewards towards the end of a game as very labour intensive, due to the huge amount of work that is required for a small magnitude reward. This adds evidence to the potential holding power of in-game ratio-reinforcement while also showing the effectiveness of the schedule thinning technique in continuing the behaviour, despite a potential drop in enjoyment from the activity.

Further gaming research built upon King et al.’s (2010) study and aimed to explain what elements of videogames were motivationally important to individual

players' gaming experiences (Westwood & Griffiths, 2010). This study attempted to uncover what psycho-structural elements of videogames encouraged users to continue to invest time. They found that a large subgroup of gamers were strongly motivated by the rewards of both central and side goals that the game offered. One of the factors that categorised these gamers was a potential to lose track of time when pursuing these in-game rewards (Westwood & Griffiths, 2010).

To date, largely only self-report evidence (e.g. Yee, 2006; King et al., 2010; Westwood & Griffiths, 2010) has documented the influence of reinforcement schedules on the maintenance of gaming behaviour. Given the well-established limits of self-report measures, observing the effect of an experimental manipulation of independent reinforcement schedules on gameplay duration would provide stronger evidence in regards to the effectiveness of varied reward structures.

The basic operant conditioning principle evidence presented above would suggest that intermittent in-game reinforcement alone is likely to increase gameplay duration. There is also evidence to suggest that a variable-ratio schedule applied to videogame reinforcement is likely to produce a higher rate of desirable behaviour, in this case playing duration, when compared to a fixed-ratio schedule of reward. Evidence also suggests that the effects of in-game reinforcement on gameplay duration can be enhanced via effective schedule thinning. Thus, for both our fixed- and variable-ratio schedules, we thinned reinforcement over time.

### **Self-Determination Theory and the Psychological Need for Competence**

Although the principles of operant conditioning provide an obvious mechanism through which rewards might prolong gameplay, an alternative mechanism is presented via self-determination theory and the psychological need for competence.

An automatic process refers to the activation in a sequence of mental processes that happen consistently when in a particular situation (e.g. flight reaction from a threat), whereas a deliberate action is under thought and control of the individual (e.g. choosing a route to travel; Schneider & Chein, 2003). Structurally, videogames are able to motivate significant amounts of goal-directed behaviour (Przybylski et al., 2010) through automatic processes rather than deliberate actions (Hartmann, Jung & Vorderer, 2012). Bartle (2004) suggests that gamers either consciously or subconsciously expect to gain something from the time they invest in video-gaming which works to increase their motivation to participate (as cited in Ryan et al., 2006). Gamers may need to feel as if they are fulfilling a psychological need for gaming behaviour to continue, simply enjoying a videogame may not be enough (Ryan et al.). Motivation to videogame and the associated psychological gratification that gamers receive might be explained by self-determination theory (SDT; Ryan et al.).

SDT is concerned with inherent human motivation towards social contexts which fulfil three psychological needs; competence, relatedness and/or autonomy (Przybylski et al., 2010). A sub-section of SDT; Cognitive Evaluation Theory (CET) suggests that fostering these needs with external reinforcement works to enhance intrinsic motivation to maintain task behaviour (Przybylski et al., 2010). Providing reinforcement to players assists in fulfilling this psychological need of competence by providing positive feedback about the player skill set being advanced enough to complete the goals of the videogame (Przybylski et al., 2010). The pacing of challenges and the subsequent reinforcement is an essential part to eliciting this feeling of competence within a player. If goals are too hard or too easy, players gain no competence fulfilment, diminishing their motivation to continue playing

(Przybylski et al., 2010). Early videogames had a large focus on fulfilling this need for competence as a means to keep players in the gaming environment (Przybylski et al., 2010). Games such as *Pong*, the arcade style tennis game, gradually increased in difficulty as players completed subsequent levels, scoring points. These points act as a very basic in-game reward that provide feedback about player competence developing (Przybylski et al., 2010). Although videogames have moved away from this arcade style, the ability of developers to pace the in-built challenges to suit player skill levels is one of prime concern.

The effectiveness of competence fulfilment has shown to relate strongly to greater game enjoyment, immersion, and a preference for future play (Przybylski et al., 2010). If game-play behaviour continues to be gratifying to this psychological need for competence, it is likely that the behaviour will continue (Hartmann et al., 2012), potentially contributing to addictive tendencies (Griffiths, 1996). This suggests videogames that make use of in-game rewards to fulfil player competence needs (in comparison to those who give no feedback), may increase motivation to play, increasing gaming duration.

In order for in-game rewards to fulfil this need for competence, individuals must believe the received rewards are related to their in-game progress and, thus, their skill set. Varying the timing of rewards is more likely to elicit player belief that their unique actions are being rewarded, when compared to fixed-ratio rewarding where players may feel as if they are arbitrarily receiving the rewards on a schedule. Without this positive feedback about player skill set, the reward schedule may violate the psychological gratification of competence, reducing motivation and thus gaming duration.

Self-determination theory would thus suggest that variable-ratio videogame reinforcement is likely to increase gameplay duration when compared to fixed-ratio reinforcement as in-game rewards are more likely to be perceived as relating to player abilities (instead of arbitrary actions on a predetermined schedule), gratifying this inherent need for competence.

### **Flow**

A third possible mechanism through which in-game rewards might influence gameplay duration, is the psychological experience of “flow” (Csikszentmihalyi, 1997). It is important to state that the measurement of flow in the current study was undertaken on a largely exploratory basis due to the limited research linking it to video-gaming, as well as an absence of reliable measures.

Successfully promoting player engagement is central to the effectiveness and popularity of videogames. Engagement is partially associated with external stimuli that assist in promoting an initial interest in, and then the continuation of, gameplay behaviours (Jones, 1998). Interest, the main indicator of engagement provides intrinsic motivation, initiated by this external feedback that players are exposed to (Jones, 1998; in Evans et al.). Videogames which provide immediate feedback about player progress and task completion promote emotional immersion in the gaming world (Przybylski et al., 2010). Thus, immersion and engagement may be key concepts in understanding prolonged gameplay and problematic video-gaming behaviours (Douglas & Hargadon, 2000).

‘Flow’, a psychological state resulting from engagement and immersion, refers to emotional investment in an activity, characterised by a decreased appreciation and underestimated judgements of other cues (e.g. time; Chou & Ting, 2003; Csikszentmihalyi, 1997). Research evidence has shown strong positive

correlations between excessive gaming and the presence of a flow experience (Cowley, Charles, Black & Hickey, 2008). For example, Hull et al. (2013) tested participants for presence of a flow state while playing videogames. They found that the concept of ‘perceptions of time being altered during play’ as measured on the Flow state scale, was a significant indicator of gaming addiction. As such researchers are starting to utilise Csikszentmihalyi’s concept of ‘flow’ to explain why in-game rewards seem so important to players and their meta-motivational player experience (e.g. the experience they are striving for; Cowley et al., 2008). Derived from Csikszentmihalyi’s (1997) original eight elements of flow, is ‘Flow Theory’ which suggests three conditions must be met to achieve this flow state. The first of these is a clear set of goals and progress, which provide individuals with structure and direction when completing a challenging task. The second is immediate feedback which suggests that rewarding desirable behaviour provides individuals with information that they are progressing in the right direction. The last is a balance between perceived challenges and skill; inferring that individuals must feel that their goals are achievable despite being challenging (Csikszentmihalyi et al., 2005). According to flow theory, if videogames are able to induce flow characteristics by providing players with challenging goals and immediate feedback, the player will become less conscious of the passage of time (Cowley et al., 2008). Flow theory would thus suggest that a videogame without reinforcement will not fulfil the need for immediate feedback and as such is unlikely to alter player perceptions of time, resulting in a shorter playing duration.

Videogame research has documented the potential influences of flow-like characteristics in prolonging gameplay. Westwood and Griffiths’ (2010) self-report study suggested that a large percentage of gamers reported ‘lost time’ when playing

videogames. This time loss was interpreted as the gamer fully entering into the world of gameplay and was reported as a positive experience. However, this time loss was only seen to occur when the gamer had no other use for the lost time (Westwood & Griffiths, 2010). This suggests that a flow like experience when gaming may be mediated by commitments outside of that gaming environment. To promote full investment and to see an influence of flow effecting gaming duration, players may need to be totally immersed in the gaming environment and free from all other concerns. This may be difficult to measure in an experimental setting where gamers are not consciously choosing to play but are instead being asked to. However if gamers are free from outside concerns, the initiation of a flow state may work to increase gaming duration through an underestimated judgement of time.

Theoretically, feedback is a necessary precondition for the initiation of a flow state. Within a video-gaming environment, feedback may come in the form of in-game reinforcement which encourages and rewards desirable playing behaviours. Reward features provide the necessary immediate feedback to maintain the internal balance between players' perceived skills and perceived challenges, resulting in a decreased appreciation of time and thus potentially contributing to prolonged gameplay durations.

### **The Present Research**

The primary aim of the current study was to determine if altering the structural characteristic of in-game ratio- reinforcement alone (i.e. without providing other enjoyable characteristics) can significantly increase gaming duration. Based on the evidence presented for the proposed mechanisms relating to basic operant conditioning, the psychological need for competence and flow, it is hypothesised that ratio reinforcement that rewards players for continuing to engage with the game is



likely to increase their video-gaming duration when compared to a no reinforcement control condition. The secondary aim was to determine differences between the effects of fixed- and variable-ratio reward schedules on gameplay duration.

Competence and operant conditioning research also suggests that within ratio reinforcement, variable-ratio configured rewards will lead to a significantly longer duration of gaming when compared to fixed-ratio rewards. As an added exploratory measure, we also test whether ratio-reinforcement significant increases self-reports of a flow state in gamers, when compared to a no reinforcement control condition.

## **Method**

### **Design**

The current study used a one way between subjects design. Reinforcement condition acted as the independent variable, with three levels; a control condition with no in-game reinforcement, a fixed-ratio reinforcement condition and a variable-ratio reinforcement condition. The effectiveness of reinforcement was measured by multiple dependant variables including gameplay duration, level restarts (i.e. a measure of persistence), and self-reported flow (via the Flow Condition Questionnaire: FCQ; Shaffer, 2013). We also measured previous gameplay experience but given the absence of regular gamers, this was not considered in any analysis.

### **Participants**

The study used a total of 51 participants, allowing 17 per reinforcement condition. The majority of these were recruited from the University of Tasmania and were paid with \$15 Coles/Myer gift vouchers. There were also a small amount of first year

psychology students who received course credit for participating. The only restriction to recruitment was that participants must have been over the age 18.

### **Apparatus/Instrumentation/Materials**

**The Videogame.** A custom videogame run on a standard windows computer was the main testing apparatus. The videogame was an electronic version of chess-based puzzle game, *A Knight's Tour*. Participants chose a starting point on a grid of squares resembling a chess board (Figure 1) and were required to move their marker around the grid using the knight movement pattern from the board game, chess (two blocks forward and one to either side). Their goal was to land on every square once, without landing on any one square twice. The grid began at 5x5 squares and grew progressively larger as subsequent levels were completed (6x6, 8x8 and 10x10), with four in total. When participants reached a point where no more moves were possible, they were able to restart the level. In short, this game was utilised as it has very little intrinsic appeal to players.

Described above is the control version of the game in which players received no in-game reinforcement. Along with the control version, the study used fixed- and variable-ratio reinforcement versions which awarded participants trophies for clearing squares, regardless of their progress. In these two conditions, participants had the opportunity to receive four types of in-game trophies:

**Block-Breaker Trophies.** The block breaker trophies were the main type of in-game reinforcement used. Participants could be awarded up to a total of 20 which were arranged into four groups of five trophies (bronze, silver, gold and platinum). These were awarded based on the amount of blocks participants cleared while trying to complete levels. The total blocks cleared continued rising despite either reaching a new level or restarting a level. Therefore participants received block-breaker trophies

simply for continuing to move their marker around the board. In the fixed-ratio condition, utilising the principles of schedule thinning, each of the five bronze trophies were awarded after 20 blocks were cleared, silver after 30, gold after 50 and platinum after 80, resulting in a requirement of 900 blocks cleared to receive all block-breaker trophies. In the variable-ratio condition, the five bronze trophies were awarded on an average of 20 blocks cleared, the silver on an average of 30, the gold on an average of 50 and the platinum on an average of 80, resulting in the same 900 blocks cleared to receive all twenty block-breaker trophies.

***Level Completion Trophies.*** There were four level completion trophies in total, received if participants completed the 5x5, 6x6, 8x8 and 10x10 grids. They were consistent across the fixed- and variable-ratio conditions and were included to mimic modern videogames.

***Persistence Trophies.*** A total of four persistence trophies were awarded to participants. They were awarded at 180 blocks cleared, 390 blocks cleared, 630 blocks cleared and the last at 920 blocks cleared. These were thinned by an extra 30 blocks for each award and were consistent across both the fixed- and variable-ratio conditions. Once again, they were awarded despite the amount of levels completed.

***First-Steps Trophy.*** A once-off trophy presented for the first square participants cleared. It was included to mimic an initial modern game reward. In-game trophies, when earned, appeared below the game-play grid (pictured in Figure 1) accompanied by a simple ‘chime’ audio sound. Each trophy notification showed the progress of participants through that particular set of trophies with a progress bar below the name of the reward. The trophy notifications remained on the screen for four seconds before disappearing. All were designed using a template from

an achievement generator (says-it.com, 2015) in order to mimic actual videogame rewards.

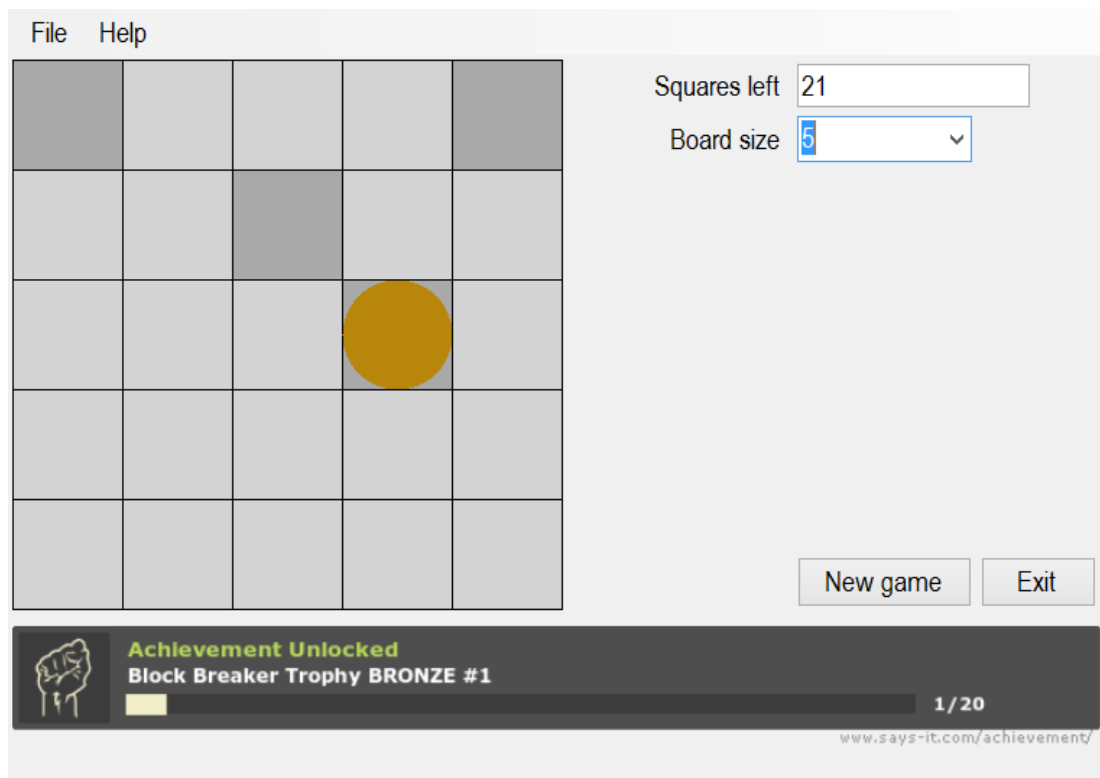


Figure 1. Screenshot of, *A Knight's Tour* (showing reinforcement placement).

Based on King et al.'s (2010) self-report findings on enjoyable aspects of video-gaming, all enjoyable aspects, with the exception of the reward features, were removed. This was done in an attempt to isolate the influence of reward structures on gaming duration (e.g. there was no storyline associated with the game).

The game was coded to automatically record participant number, experimental condition, playing time, levels completed, blocks cleared and rewards achieved. This results package was accessible as an external text file.

**Participant Information Sheet (Appendix B).** The participant information sheet included an invitation to participate, information on anonymity of participants and their data, as well as general information about the purpose of the study. Due to the malleable nature of our dependant measures, we were unable to provide all

information about the aims of the study due to the likelihood that it would influence results.

**Participant Consent Form (Appendix C).** The consent form provided general information about the study as well as the rights of the participants. It required a participant signature before testing commenced.

**Frequency of Videogame Play Survey (Appendix D).** The frequency of videogame play survey was administered prior to the testing period and included questions regarding the participant's involvement with a number of different gaming platforms within the past three months.

**Flow Condition Questionnaire (FCQ; Shaffer, 2013; Appendix E).** The FCQ was administered following the testing period. It required participants to recall their experiences while playing *A Knights Tour* and tested for the presence of flow experience while in the testing period. The seven items on the FCQ relate to essential elements of flow and their corresponding gameplay attributes, proposed by Jones (1998). For example questions such as "What to do next?" or "Where to go next?" provide a measure of how clear the goals of the game were, an essential element of flow.

**Debrief Form (Appendix F).** After the testing period and FCQ was completed, participants were provided a debrief form. This included information regarding the goals behind the study, information on how to have their data removed if participants so wished, as well as information on how to access the results and conclusions of the study after completion. It also included a request of participants to avoid sharing the goals or aims of the study with potential future participants due to the possible influence participant knowledge would have on our dependant measures.

**A Knight's Tour – Instruction Sheet (Appendix G).** The instruction sheet provided information on how to play *A Knight's Tour*. It included explicit instructions to participants to only play for as long as they wished.

**A Knight's Tour – Trophy Cabinet (Appendix H).** The trophy cabinet was only shown to participants in the variable- and fixed-ratio reinforcement conditions. It pictured all of the rewards available to them, however provided no information on how to achieve these.

### **Procedure**

Ethics approval for the current framework was granted on May 22<sup>nd</sup>, 2015. A copy of this approval can be seen in Appendix A.

Participants were asked to read the participant information sheet as well as the consent form and were encouraged to ask questions if anything was unclear before choosing to provide consent. They then completed the previous gameplay experience questionnaire.

Providing they gave consent, participants were assigned to one of the three reinforcement conditions based on the order of testing (e.g. the first participant was assigned to the control condition, the second to the fixed-ratio condition, third to the variable-ratio condition, fourth to the control, and so on).

Participants read the *Knight's Tour* instruction sheet, as well as the trophy cabinet document (only in the reinforcement conditions). Before they began participants were instructed to try and finish all four levels, but to only play for as long as they wished. They were then asked to place headphones on so as to reduce any audible distractions.

When participants had finished playing, they completed the FCQ (Shaffer, 2013) and were provided with a debrief form. They were then given a chance to ask any questions regarding the design of the study.

After participants had left the testing area, their gameplay statistics were collected from the data and entered into an SPSS spreadsheet for later analysis.

## **Results**

### **Data Screening**

Data analysis was completed on all 51 participants. Tabachnick and Fidell's (2007) method of 3.29 SDs for outlier removal was implemented and no data points were removed. The data set was checked for skewness and kurtosis which both indicated that no data transformation was required. The homogeneity of variance assumptions were also checked, which were only violated in the 'level restarts' analyses and as such, unequal variances assumed data was used. It is important to note that although playing time was measured in milliseconds, it was converted to minutes for ease of interpretation.

### **The Effects of Reward Schedules on Playing Time**

The descriptive statistics for the three dependant measures (playing time, level restarts and flow) split by reinforcement condition, can be seen in Table 1. A planned linear contrast was run to test for a significant difference in playing time between the control condition and the reinforcement conditions. This contrast revealed a large effect, with participants in the reward conditions playing for significantly longer than those in the control condition,  $t(48) = -3.03$ ,  $p = .004$ ,  $d = .87$ . A second linear contrast indicated no significant difference between the variable-ratio and fixed-ratio conditions,  $t(48) = -1.45$ ,  $p = .154$ ,  $d = .42$ . However, the effect size for this comparison approached the cut-off for a moderate effect, suggesting that the study

was potentially underpowered. If the power was increased, it is possible a significant difference would indicate that, as predicted, variable-ratio reinforcement facilitates longer gameplay than fixed-ratio reinforcement.

**Table 1**

*Descriptive Statistics for Playing Time, Level restarts and Flow Ratings According to Reinforcement Condition.*

Condition	Dependent Measures					
	Playing duration		Restarts		Flow	
	(minutes)					
	M	95% CI	M	95% CI	M	95% CI
Control	18.40	±5.06	21.24	±4.31	23.24	±2.41
Fixed Ratio	26.22	±5.21	30.88	±6.69	24.65	±2.27
Variable Ratio	32.20	±6.73	36.47	±10.15	25.71	±1.45

### **The Effects of Reward Schedules on Restarts**

As a further measure of willingness to continue playing, level restarts were also analysed across conditions. This measure was also seen as an indicator of the effects of the reward manipulation of persistence following failure.

Again, we ran a planned linear contrast to test for potential differences between the control and the reinforcement conditions. The contrast revealed a significant effect, approaching the cut-off for a large effect, with participants in the reinforcement conditions willing to restart the game significantly more than those in the control condition,  $t(43.50) = 3.274, p = .002, d = .77$ . A second linear contrast indicated no significant between variable-ratio and fixed-ratio conditions in level restarts ( $t(27.69) = .901, p = .375, d = .30$ ). Once again, the effect size was above a



small effect cut-off, suggesting that an increase in power may yield results indicating that players in the variable-ratio condition restart the game significantly more than those in the fixed-ratio condition, as predicted.

### **The Effects of Reward Schedules on Flow**

In our exploratory analysis, post-gameplay self-ratings of flow were tested for significant differences between the control and experimental conditions. A planned linear contrast indicated a small effect, however non-significant difference between the control and the two reinforcement conditions,  $t(48) = 1.49$ ,  $p = .143$ ,  $d = 0.21$ . The same was found in the second contrast with no significant difference between the fixed-ratio and variable-ratio conditions,  $t(48) = .703$ ,  $p = .485$ ,  $d = .20$ , with a small effect size noted once again.

### **Discussion**

The results showed strong support for the ability of in-game reinforcement to significantly influence gameplay duration, confirming hypothesis one. Participants in the reinforcement conditions on average played for approximately 29 minutes compared to those in the control condition who played on average for approximately 18 minutes. This finding is consistent with a multitude of both theoretical and experimental (human and animal) operant conditioning research suggesting that a reinforced behaviour is likely to continue for longer than one that is not reinforced (e.g. Thorndike, 1927; Thorndike, 1898; Skinner, 1963, Verplanck, 1956; Siqueland & Lipsitt, 1966). It is also consistent with self-determination theory's concept of competence in explaining how positive feedback contributes to psychological gratification and an associated extended gameplay duration (Przybylski et al., 2010; Ryan et al., 2006; Hartmann et al., 2012).

Although the difference in gameplay duration between the fixed-ratio (26minutes on average) and variable-ratio (32minutes on average) conditions was non-significant, the effect size bordering on medium strength is strong evidence to suggest that given more power a significant difference (in the anticipated direction) may have emerged. This partial finding is consistent with operant conditioning literature suggesting the effectiveness of variable-ratio reinforcement over fixed-ratio reinforcement (e.g. Skinner 1953; Ferster & Skinner, 1957; Field, 1996; Lagorio & Winger, 2014). It was also in line with predictions that any observed difference between reinforcement groups would be less than that between reinforcement and control.

The results indicate the substantial influence of simple reinforcement characteristics on the amount of time players were willing to invest into the videogame. The addition of variable-ratio rewards to the control version of *A Knight's Tour*, almost doubled gameplay duration despite the absence of any real benefit of the rewards. For example the rewards that players received were extremely trivial in design, offering no benefit to them within the gaming environment, no physical external rewards, and no social status benefits as results were private, yet they were still able to greatly influence gaming duration. Conceptually, this is very important given the concerns regarding problematic gaming durations (King et al., 2011). If one videogame characteristic with no benefit to players can double the time they are willing to invest, it is worrying when a range of other enjoyable characteristics are returned to the game's structure. Our simple reward structures, based on very basic principles of operant conditioning, suggest that by reinforcing gameplay behaviour (even with relatively trivial rewards) we can substantially increase the gameplay duration of participants.

It is evident that findings similar to these are already influencing poker-machine design, reinforcing players to invest more time and thus, money (Delfabbro & Winefield, 1999). Gambling literature would suggest that the more often players come into contact with these types of reinforcement, the greater the influence it will begin to have over them (Delfabbro & Winefield, 1999). This leads to a dangerous spiral where the more players play, the more they are influenced by the reinforcement but the stronger these rewards influence them, the greater their willingness to play. If gambling structures can have this influence on participants, it is likely that similar design structures within videogames will have the same effect. This in itself is quite concerning given the potential for even the simplest of rewards structures in our videogame to exert a powerful holding influence over participants, which according to gambling literature, may continue to get worse as players engage more with the videogame.

It is also important to note the ability of our reinforcement findings to assist in explaining the recent popularity of the freemium genre. Predominately mobile games (e.g. *Family Guy: The Quest for Stuff*) are utilising in-game rewards to raise player motivation and then imposing waiting periods which can only be bypassed by depositing money (Page, 2012). If the simplest in-game reinforcement can be used to almost double the duration for which gamers wish to play, then with more enjoyable structures it may be possible to increase player motivation to a point where they are unwilling to cease playing. If this occurs and players are presented with the opportunity to deposit money to continue playing, the reinforcement characteristics can contribute to impulse buying behaviours. This can cause significant problems with the way that micro-transactions are configured to facilitate fast and easy impulse buying (Page, 2012). The effectiveness of in-game reinforcement in

maintaining player motivation can explain how users are structurally motivated to spend money within a freemium context. Thus, as seen in poker-machine gambling, the inclusion of reward schedules in freemium gaming may have significant economic consequences for gamers.

As a further analysis of gameplay intent, we examined the effect of reinforcement on participants' willingness to restart a level after failure. The findings added strength to the first hypothesis with players in the control condition restarting the game on average 21 times, when compared to 34 times in the reinforcement conditions. The finding was supported by a range of operant conditioning research showing the effectiveness of reinforcement in behavioural persistence (e.g. Thorndike, 1927; Thorndike, 1898; Skinner, 1963, Verplanck, 1956; Siqueland & Lipsitt, 1966).

Although the difference was non-significant, the effect size indicated that there may be a meaningful difference between the fixed-ratio and variable-ratio conditions given a more powerful analysis. This would be in line with our previous predictions.

The level restart findings are conceptually important given that it indicates rewards do not need to be contingent on success to affect player behaviour. When variable-ratio rewards were introduced to the control version of *A Knight's Tour*, the amount of restarts participants were willing to make increased by over 70%, suggesting that in-game rewards also work to increase the persistence of gamers. It is important to note that previous research identified having to start a level from the beginning as a factor that gamers found unenjoyable and in even some cases, as somewhat of a punishment (Wood et al., 2004). This suggests that even when

participants were faced with a task that was not considered enjoyable, the reward characteristics of the game increased participant willingness to continue playing.

Rewards presented for accomplishing meaningful goals are considered the most effective at enhancing gaming motivation and contributing to an extended gaming duration (Garris, Ahlers & Driskell, 2002). However, the effectiveness of the reinforcement in the current experiment suggests that rewarding players for simply continuing to attempt the same goal has significant holding power. This shows that despite gamer skill level, reinforcement can have a major effect on playing duration. Research suggests that the most effective games are able to manipulate a player sweet spot between how challenging goals are and how able players feel they are to complete these goals (Granic et al., 2014). While this might be the case, continuing to reward players purely for attempting to complete goals can have a significant influence on their persistence levels and, thus, the amount of time they are willing to spend gaming.

Although the analysis of flow by reinforcement condition was carried out on an exploratory basis, the results pose interesting questions for future research. Both flow contrasts, control compared to reinforcement and fixed-ratio compared to variable-ratio, indicated small effect sizes in the expected directions despite non-significant differences. These once again suggested that increasing the power of the analysis may have yielded significant differences in the expected direction.

Theoretically, videogames have the ability to fulfil all conditions necessary to produce a flow state (Csikszentmihalyi et al., 2005). Csikszentmihalyi's three conditions for a flow state stipulate that; there must be a clear set of goals and progress, there must be immediate feedback and there must be a balance between perceived skills and perceived challenges. The reinforcement conditions fulfil this

need for feedback by informing players of their progression, which the control condition failed to do. Theory would suggest that a flow state leads to both engagement and immersion where players begin to lose track of time, likely extending gaming duration (Csikszentmihalyi et al., 2005). As the game was specifically designed to remove all enjoyable aspects (apart from the rewards) of modern games (King et al., 2011), the meaningful effect sizes are somewhat surprising. It suggests that despite the simplicity of our rewards, flow may be one of the mechanisms through which videogames promote extended or even problematic gaming durations.

This finding is especially intriguing given the notable limitations of our flow measure. As touched upon, the FCQ (Shaffer, 2013) was not designed to measure flow in a videogame context but was used in the absence of any alternative measure. As the questionnaire items were not designed for video-gaming, we were unsure if the measure would index the relevant construct in this context. It also became evident throughout the testing period that the FCQ had a number of ambiguous questions, not identified in the screening phase. An example of this was the first item which asked, “How much of the time did you know what you had to do to complete your goal?” The FCQ would suggest that this rating should be high as participants are aware of the goal they need to accomplish (e.g. landing on all the squares once). However this was interpreted by a substantial amount of participants as a low rating answer because they were unaware of how to practically go about completing the goal (e.g. where to move next). We would expect questions such as these to reduce any statistical differences between reinforcement conditions. These factors potentially combined with our relatively low power to produce the non-significant

differences, despite the theoretical backing for why we would expect to see more meaningful differences.

A major limitation of the current study was the sample size. From the results, it is evident that a cell size of 17 participants was not enough large enough to detect the less robust differences between experimental groups. For example, the effect size of 0.42 between the fixed-ratio and variable-ratio conditions during the playing time analysis was bordering on medium size, however was statistically non-significant. The study's low power also failed to show a significant difference between the fixed-ratio and variable-ratio conditions on level restarts with an effect size between the small and medium cut-offs. Other evidence was found in both the flow analyses where small effect sizes failed to reach significance. Despite it being an obvious limitation, it is one that is conceptually very easy to fix and would have been done given a longer testing period. Even with the problematic power size however, the results showed the robust nature of the differences between our reinforcement and control groups on both playing time and level restarts.

A second limitation is the tendency for *A Knight's Tour* to create a 'near-miss effect.' Wadhawa and Kim (2015) suggest that the closer we get to completing a goal, the more motivation we will retain to continue playing (Wulfert, Maxson & Jarden, 2009) which will inevitably decrease the chance of goal disengagement (Dixon & Schreiber, 2004). This indicates that structural design characteristics promoting a 'near-miss' are likely to encourage increased playing durations. In the current study, the closer participants came to finishing levels, the more game-directed motivation they would have retained, naturally increasing the amount of time they spend playing and unintentionally introducing the variable of player ability. It is likely that random allocation of participants would have offset this effect

across reinforcement groups but it is important to note that the reinforcements may not have been the only variable influencing gaming duration.

It is important to note that the rewards used in the current study are likely to mimic only one very basic type of reward used in modern videogames. Modern gaming rewards are commonly awarded for the completion of goals in a variety of different tasks, whereas rewards in the current study were awarded simply for continuing to interact with the game. To build on the evidence we have presented for the most basic reinforcement in prolonging gaming duration, future research must expand into more modern gaming rewards. For example, gaming achievements that unlock new levels, characters or opportunities within a videogame (i.e. those with some in-game value) are likely to have significantly more holding power than those seen in the current experiment. Similarly, rewards that confer some social status on the player relative to their peers (e.g., Microsoft *Gamescore* points) may exert larger effects on gameplay duration. Increasing the variety of these rewards also allows a greater potential for modern games to manipulate a player sweet spot between challenge and progress, contributing to stronger motivation to game (Granic et al., 2014). The most successful videogames are able to create goals that are challenging to players, in order to avoid boredom, but keep the goals close enough to players so they never feel as if they are unreachable. If either of these scenarios occur, goal disengagement is likely. Therefore, with more modern gaming environments, there is a greater ability for videogame reinforcement to contribute to the gaming experience. This provides more opportunity to induce greater enjoyment and inevitably magnify the already strong effects seen in the present study.

Along with a more advanced reward system, future research must also expand into videogames with a greater array of enjoyable characteristics. In the



current study, the goal was to isolate the influence of the reinforcement characteristics and as such all other enjoyable features were removed. King et al. (2010) suggest reward and punishment features are just one important characteristic in maintaining gameplay and identified four other important features including; manipulation and control, social, narrative, and presentation features. To generate a full understanding of how prolonged and potentially problematic gameplay durations occur, it is essential that future research begin to look at the motivational power of each videogame characteristic. If the most primitive rewards in the simplest of games can almost double the time participants are willing to spend playing, the addition of other enjoyable characteristics is likely to magnifying this effect.

The current study begins to fill a literature gap by providing evidence for the influence of simple videogame reinforcement characteristics in contributing to prolonged and potentially problematic gameplay (Wood et al., 2004). Despite the simplicity of the in-game reinforcement and the absence of any external benefit they provided to players, they were shown to greatly impact the amount of time users were willing to spend playing. Further, this study provides evidence for the influence that individual videogame characteristics can have on not only gameplay duration but also persistence in continuing to attempting the same goal despite regular failure. The study also provides a first step in understanding how freemium game structures may manipulate users into willingly depositing money. Raising player motivation through the use of reinforcement and then imposing waiting periods can contribute to a player motivation that makes it difficult to stop playing.

In conclusion, the current study aimed to experimentally examine the degree to which in-game reinforcement influenced player gaming duration and persistence. Results from the study indicate that reinforcement based on desirable responses,

significantly increased player gaming duration. There is also some evidence to suggest that reinforcement presented on a variable-ratio schedule has greater player holding power when compared to a fixed-ratio schedule, albeit a weaker relationship when compared to no reinforcement. Thus, the study contributes experimental evidence to suggest how videogame reward characteristics can significantly contribute to prolonged or even problem gaming.

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## Appendix A: Ethics Approval Letter

Social Science Ethics Officer  
Private Bag 01 Hobart  
Tasmania 7001 Australia  
Tel: (03) 6226 2763  
Fax: (03) 6226 7148  
Katherine.Shaw@utas.edu.au




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HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

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22 May 2015

Dr Jim Sauer  
Psychology  
Private Bag 30

*Sent via email*

Dear Dr Sauer

**Re: MINIMAL RISK ETHICS APPLICATION APPROVAL**

**Ethics Ref: H0014954** - The Influence of Video Game Reinforcement Schedules on Game Play

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We are pleased to advise that acting on a mandate from the Tasmania Social Sciences HREC, the Chair of the committee considered and approved the above project on 21 May 2015.

This approval constitutes ethical clearance by the Tasmania Social Sciences Human Research Ethics Committee. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approval of other bodies or authorities is required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

Please note that this approval is for four years and is conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

The following conditions apply to this approval. Failure to abide by these conditions may result in suspension or discontinuation of approval.

1. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval, to ensure the project is conducted as approved by the Ethics Committee, and to notify the Committee if any investigators are added to, or cease involvement with, the project.

2. Complaints: If any complaints are received or ethical issues arise during the course of the project, investigators should advise the Executive Officer of the Ethics Committee on 03 6226 7479 or [human.ethics@utas.edu.au](mailto:human.ethics@utas.edu.au).
3. Incidents or adverse effects: Investigators should notify the Ethics Committee immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
4. Amendments to Project: Modifications to the project must not proceed until approval is obtained from the Ethics Committee. Please submit an Amendment Form (available on our website) to notify the Ethics Committee of the proposed modifications.
5. Annual Report: Continued approval for this project is dependent on the submission of a Progress Report by the anniversary date of your approval. You will be sent a courtesy reminder closer to this date. **Failure to submit a Progress Report will mean that ethics approval for this project will lapse.**
6. Final Report: A Final Report and a copy of any published material arising from the project, either in full or abstract, must be provided at the end of the project.

Yours sincerely

Natasha Jones  
Ethics Officer  
Tasmania Social Sciences HREC

## Appendix B: Participant Information Sheet

Locked Bag 30 Hobart

Tasmania 7001 Australia

Phone (03) 6226 2051, Fax (03) 6324 3168

jim.sauer@utas.edu.au



### The Influence of Video Game Features on Video Game Playing Behaviours

*Information Sheet for Participants*

#### 1. Invitation

You are invited to participate in a study aimed at understanding the effects of videogame features on game playing behaviour. The study is being completed as partial fulfillment of a Psychology Honours degree at the University of Tasmania by student researchers, James Thomas and Dylan Sault, under the supervision of research supervisor, Dr. Jim Sauer.

#### 2. What is the purpose of this study?

This study investigates how videogame features influence game-playing behaviour and experiences. However, the exact aims and hypotheses of this study will be withheld from you until the data collection process is complete. This is to ensure that knowledge of the study aims and hypotheses do not influence you or your responses during testing.

#### 3. Why have I been invited to participate?

You may have been invited for a number of reasons. You may have been invited on the basis of your enrollment in the Bachelor of Psychology program at the University of Tasmania. Participation in this study will contribute to postgraduate students' research projects, and contribute to first year student's course credit. Your participation in this study is entirely voluntary. There are no consequences should you chose not to participate. Should you choose to participate in this study but change your mind during your participation, you are able to withdraw at any time without penalty.

You may also be here because you responded to advertising placed around campus, or because your name is on a list of people who wish to be contacted about research participation opportunities.

In any case, your participation in this study is voluntary – you are entirely free to choose to participate or not, and there will be no consequences if you decide not to participate. If you do participate, any information you provide will be anonymous and no participants in the experiment will be individually identifiable.

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Tasmania 7001 Australia

Phone (03) 6226 2051 Fax (03) 6324 3168

jlm.sauer@utas.edu.au



### What will I be asked to do?

Should you accept the invitation to participate, you will be asked to complete a short questionnaire regarding the frequency of your videogame play. Following this, you will be presented with detailed instructions for the videogame in this study, *Knights Tour*. Playing *Knights Tour* will involve you moving a square around a grid in the shape of a chess "Knight" (two blocks vertical and one block horizontal or vice versa) in an attempt to land on every square on the board no more than once. You will be asked to play the game for as long as you wish, after which time you will be asked to complete a secondary survey questionnaire regarding your experiences and perceptions of the videogame. The research will take place in the psychology department computer lab, and the entire process should take no longer than 50 minutes.

### 4. Are there any possible benefits from participation in this study?

If you are a first year psychology student, you will receive participation credit for participating. Your participation will also provide you with experience in, and understanding of, the processes underlying scientific research. More generally, research findings will provide greater understanding of videogame design, and provide insight into the mechanisms and theory underlying videogame playing behaviours

### 5. Are there any possible risks from participation in this study?

There are no foreseeable risks or disadvantages associated with participating in this study.

### 6. What if I change my mind during or after the study?

That's fine - you are free to withdraw from the study at any time, and without providing an explanation. If you choose to withdraw during the study, your responses will be destroyed. If you complete the study, you will be able to withdraw your data if you choose to do so immediately following completion. Should you wish to withdraw at a later date, you will be able to do so by contacting the researchers and providing them with your identification code (provided on the debrief form after participation).

### 7. What will happen to the information when this study is over?

All data, including paper-based (e.g., consent forms) and electronic data (stored on password-protected hard drives) will be stored securely in the office of the research supervisor. All data will be stored anonymously, remain confidential, and be accessible by the research supervisor and student investigators only. All data will be stored for a period of five years following thesis publication, after which will be destroyed.

### 8. How will the results of the study be published?

The results of the study will be published in an academic journal. Once the study has been completed, you will be able to access the results by visiting the website below:

<http://www.utas.edu.au/psychology/research/research-project-reports>

No individual participants will be identifiable in the publication of the results.

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Tasmania 7001 Australia

Phone (03) 6226 2051 Fax (03) 6324 3168

[jim.sauer@utas.edu.au](mailto:jim.sauer@utas.edu.au)



### 9. What if I have questions about this study?

If you have any questions about this study, please feel free to contact James Sauer via phone on (03) 6226 2051 or email: [jim.sauer@utas.edu.au](mailto:jim.sauer@utas.edu.au)

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email [human.ethics@utas.edu.au](mailto:human.ethics@utas.edu.au). The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H0014954.

**This information sheet is for you to keep. If you would like to participate in this study, please ask the researcher for a Consent Form to complete.**

Thank you for your attention - your time is very much appreciated.

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## Appendix C: Participant Consent Form

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[jim.sauer@utas.edu.au](mailto:jim.sauer@utas.edu.au)



### The Influence of Video Game Features on Video Game Playing Behaviours

#### Participant Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves playing a videogame and then answering questions about my gaming experience.
5. I understand that participation involves no foreseeable risks.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived.

I agree to have my study data archived. (Note that your data will be stored anonymously.)

Yes ☐ No ☐

7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researchers will maintain confidentiality and that any information I supply to the researcher will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

I understand that I will not be able to withdraw my data after completing the experiment as my data will be anonymous.

Participant's name: \_\_\_\_\_

Participant's signature: \_\_\_\_\_

Date: \_\_\_\_\_

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Tasmania 7001 Australia

Phone (03) 6226 2051 Fax (03) 6324 3168

[jim.sauer@utas.edu.au](mailto:jim.sauer@utas.edu.au)



#### Statement by Investigator

☐

I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐

The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: \_\_\_\_\_

Investigator's signature: \_\_\_\_\_

Date: \_\_\_\_\_

## Appendix D: Previous Gameplay Questionnaire

### *Frequency of Video Game Play Survey*

Based on your video game play in the last three months, please indicate approximately how many hours per day you would typically play video games on each of the following gaming systems, for each day of the week.

If your video game play per day is less than 1 hour for any of the following gaming systems, please indicate approximately how many minutes per day you would typically play for.

	<b>Computer</b>	<b>Console</b> (e.g., <i>PlayStation,</i> <i>Xbox</i> )	<b>Mobile</b> <b>Phone</b> (e.g., <i>Candy</i> <i>Crush,</i> <i>Snake</i> )	<b>Handheld</b> <b>Device</b> (e.g. <i>Gameboy,</i> <i>Nintendo</i> <i>DS</i> )	<b>Arcade</b> <b>Games</b> (e.g., <i>Big</i> <i>Buck</i> <i>Hunter</i> )
<b>Monday</b>					
<b>Tuesday</b>					
<b>Wednesday</b>					
<b>Thursday</b>					
<b>Friday</b>					
<b>Saturday</b>					
<b>Sunday</b>					

## Appendix E: Flow Condition Questionnaire

### Flow Condition Questionnaire (FCQ)

Owen Schaffer

Please indicate how much of the time you knew each of the following while you were doing the activity by marking one circle for each question.

#### How much of the time did you know...?

	Never		About half of the time		Always
what to do next	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
how to do what you were doing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
how well you were doing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
where to go next	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please answer the following questions about how you felt while you were doing the activity by marking one circle for each question.

	Not at all				Very much
How challenging did this activity feel?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How much did you feel able to overcome the challenges you faced?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How distracted were you from what you were doing?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Appendix F: Debrief Form

Participant ID number: \_\_\_\_\_

### The Influence of Video Game Reinforcement Schedules on Game Play

This study was conducted as part of a fourth year Psychology Honours thesis at the University of Tasmania, and aimed to investigate the effects of structural characteristics within video games on participants' gameplay behaviour, and their perceptions of their gameplay experience.

Particularly, we were interested in how gameplay features like reward mechanisms can influence participants' playing behaviour, and their perceptions of gameplay. The questionnaires completed before the video gaming period measured differences in participants' prior gameplay experience, and allows us test if the effects of game-features vary according to players' prior experiences. A report on the findings of this research will be available following the completion of data collection (i.e., by mid-September), and can be obtained by contacting the researchers on the email addresses provided below.

The researchers ask that if you know somebody who is considering participating in this study that this form is not shared with them as it may potentially jeopardize later results.

James Thomas and Dylan Sault would like to thank you for participating in the current study and potentially contributing to a greater understanding of the structural characteristics within video games and their influences on behaviour.

If you have any further queries about this study, the researchers are happy to answer them now. If you think of questions at a later time, don't hesitate to contact the researchers at:

- [jethomas@utas.edu.au](mailto:jethomas@utas.edu.au)
- [dmsault@utas.edu.au](mailto:dmsault@utas.edu.au)

And they will be happy to answer any questions you may have.

If for any reason, you wish to have your data removed from the study you can contact either James or Dylan and have your data permanently deleted from the study, by quoting the participant ID number at the top of this page.

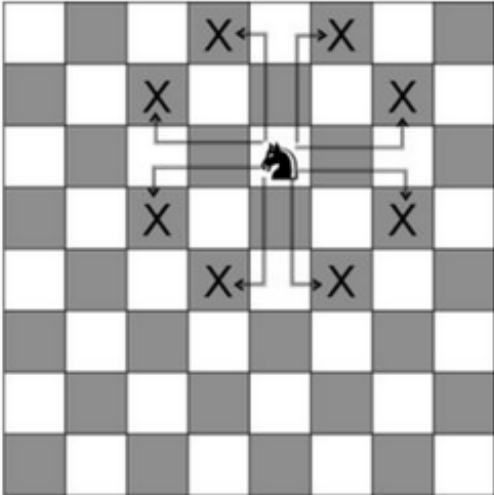
Thankyou.

## Appendix G: A Knight's Tour – Instructions

# KNIGHT'S TOUR

### Instructions

Knight's Tour is a chess-based puzzle game. Players are required to move their marker around the chess board, attempting to land on every square without landing on any one square twice. Players are however only able to move in the **'knight' movement pattern** from chess (two squares forward and one to the side), as pictured below:



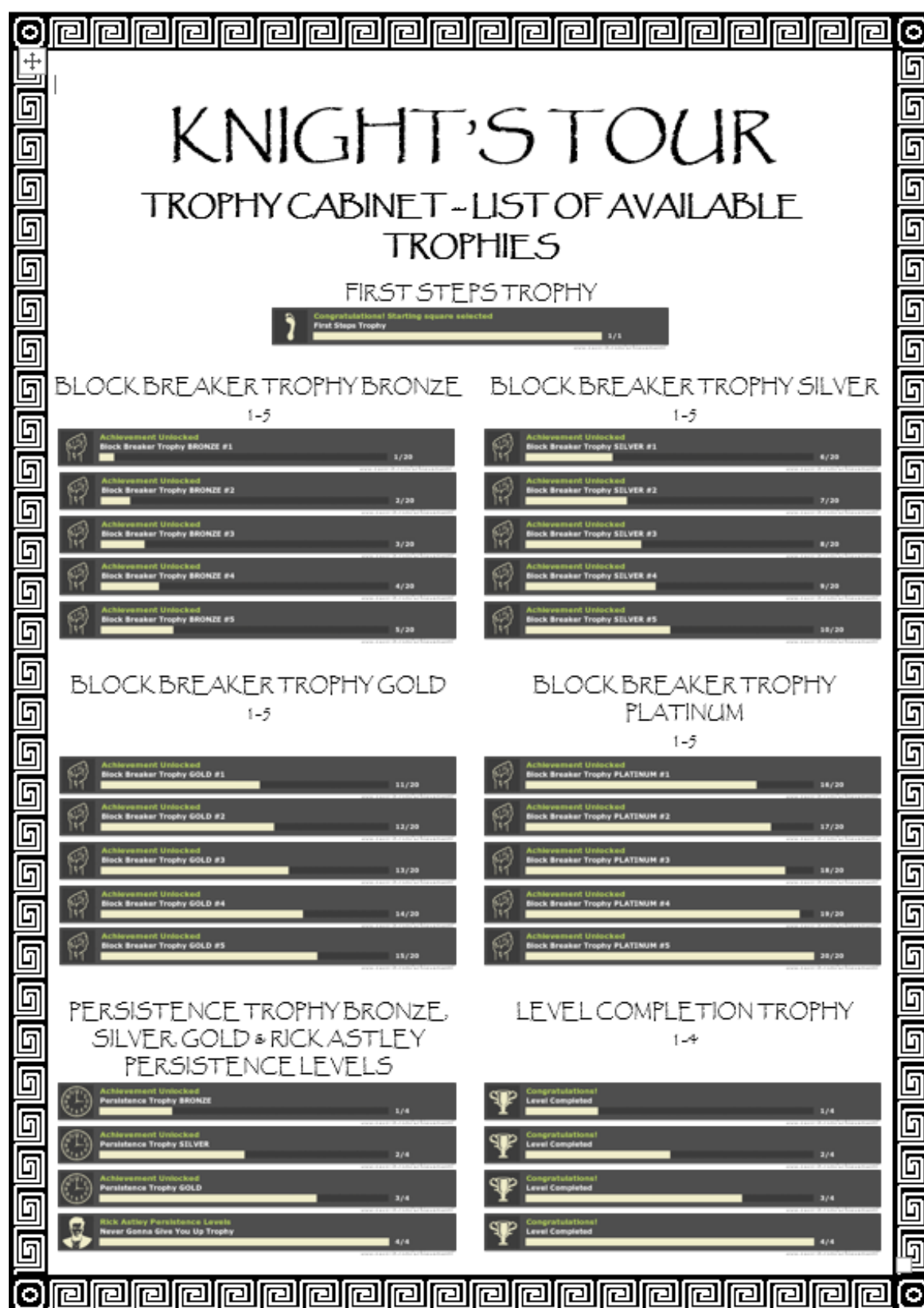
If there are no moves available the level must be restarted. There are **FOUR** levels to complete.

- Click **'START'** to begin an attempt.
- Click on any square to start the level.
- If no more moves are available, click **'NEW GAME'** to start the level again.
- Subsequent levels are only available when the ones before it are completed.
- When you are finished, click **'EXIT'** and inform the researcher.

Try to complete all levels but only play for as long as you wish. There are **no time requirements or expectations**.

If you have any questions, don't hesitate to ask the researcher. Otherwise, you are free to begin.

# Appendix H: A Knight's Tour: Trophy Cabinet



## Appendix I: SPSS Output (Flow)

### Descriptives

TFlow

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	17	23.2353	5.06865	1.22933	20.6292	25.8414	15.00	33.00
FR	17	24.6471	4.76893	1.15663	22.1951	27.0990	16.00	33.00
VR	17	25.7059	3.05706	.74144	24.1341	27.2777	19.00	29.00
Total	51	24.5294	4.41974	.61889	23.2863	25.7725	15.00	33.00

### Test of Homogeneity of Variances

TFlow

Levene Statistic	df1	df2	Sig.
2.549	2	48	.089

### ANOVA

TFlow

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	52.235	2	26.118	1.356	.267
Within Groups	924.471	48	19.260		
Total	976.706	50			

### Contrast Coefficients

Contrast	Condition		
	Control	FR	VR
1	2	-1	-1
2	0	1	-1

### Contrast Tests

		Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
TFlow	Assume equal variances	1	-3.8824	2.60722	-1.489	48	.143
		2	-1.0588	1.50528	-.703	48	.485
	Does not assume equal variances	1	-3.8824	2.81647	-1.378	26.060	.180
		2	-1.0588	1.37388	-.771	27.250	.448



## Appendix J: SPSS Output (Playing Time)

### Descriptives

TotalTime

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	17	1103823.5294	638688.18050	154904.63706	775440.3684	1432206.6904	303700.00	2.93E+6
FR	17	1573470.5882	657209.86637	159396.80572	1235564.4551	1911376.7214	806400.00	2.82E+6
VR	17	1932088.2353	849453.54338	206022.74608	1495339.5241	2368836.9465	873800.00	3.70E+6
Total	51	1536460.7843	785478.42951	109988.98013	1315541.4160	1757380.1526	303700.00	3.70E+6

### Test of Homogeneity of Variances

TotalTime

Levene Statistic	df1	df2	Sig.
1.255	2	48	.294

### ANOVA

TotalTime

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5866118598039	2	2933059299020	5.635	.006
Within Groups	24982699563529	48	520472907573.5		
Total	30848818161569	50			

### Contrast Coefficients

Contrast	Condition		
	Control	FR	VR
1	2	-1	-1
2	0	1	-1

### Contrast Tests

	Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
TotalTime	Assume equal variances	1	-1297911.7647	428598.08716	48	.004
		2	-358617.6471	247451.22100	48	.154
	Does not assume equal variances	1	-1297911.7647	404764.74638	36.834	.003
		2	-358617.6471	260485.53430	30.102	.179

## Appendix K: SPSS Output (Level Restarts)

### Descriptives

TotalRestarts

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	17	21.2353	9.05904	2.19714	16.5776	25.8930	5.00	35.00
FR	17	30.8824	14.06628	3.41157	23.6501	38.1146	11.00	61.00
VR	17	36.4706	21.34572	5.17710	25.4956	47.4455	12.00	87.00
Total	51	29.5294	16.60645	2.32537	24.8588	34.2001	5.00	87.00

### Test of Homogeneity of Variances

TotalRestarts

Levene Statistic	df1	df2	Sig.
5.673	2	48	.006

### ANOVA

TotalRestarts

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2019.647	2	1009.824	4.119	.022
Within Groups	11769.059	48	245.189		
Total	13788.706	50			

### Contrast Coefficients

Contrast	Condition		
	Control	FR	VR
1	2	-1	-1
2	0	1	-1

### Contrast Tests

		Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
TotalRestarts	Assume equal variances	1	-24.8824	9.30254	-2.675	48	.010
		2	-5.5882	5.37082	-1.040	48	.303
	Does not assume equal variances	1	-24.8824	7.59940	-3.274	43.501	.002
		2	-5.5882	6.20009	-.901	27.691	.375